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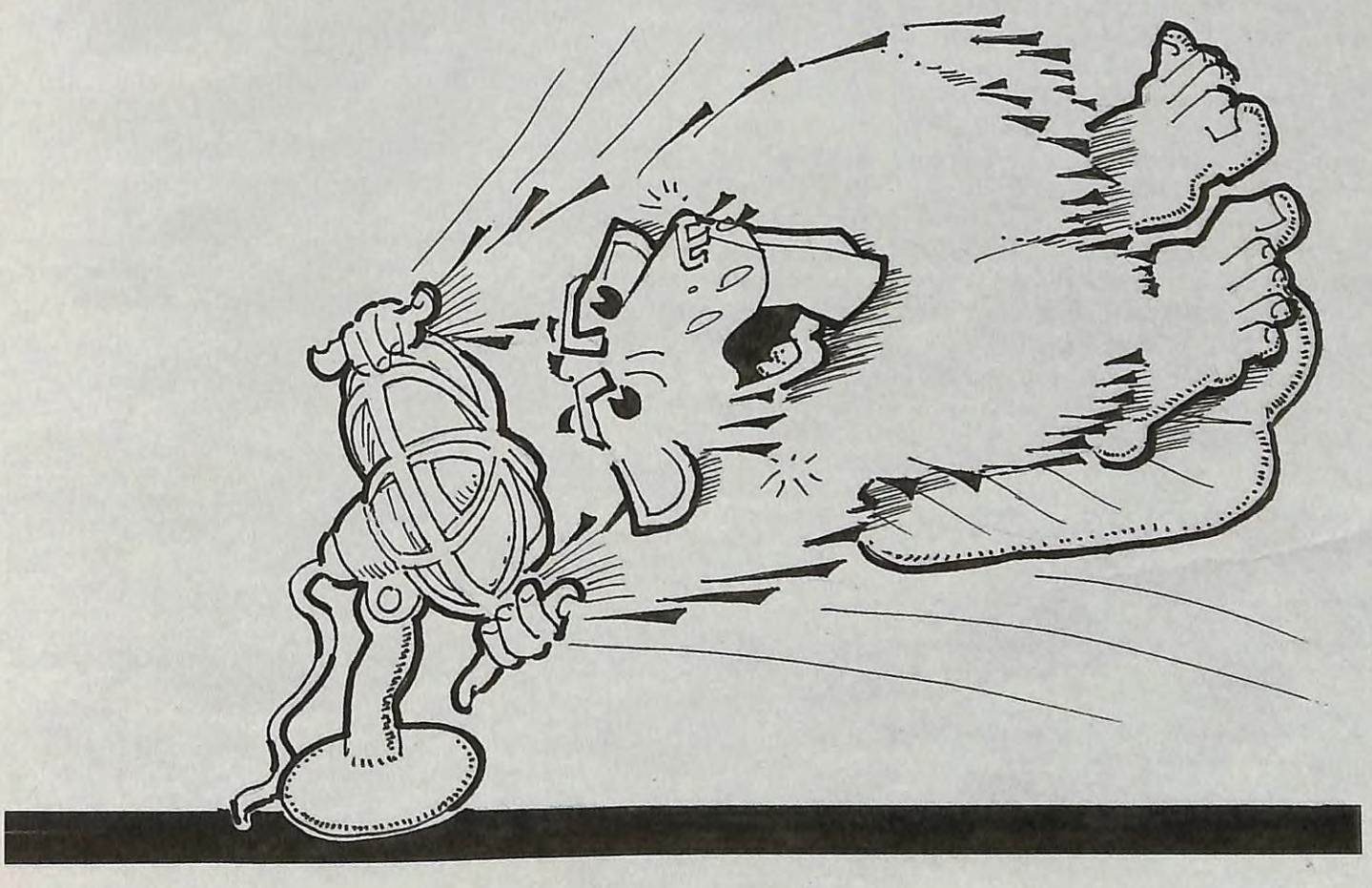


From the Editor . . .

There is no getting away from it. Although there has been a lot of discussion about environmental issues for a number of years (the Kyoto Protocol was adopted in 1997 after years of discussion), except for the most committed environmentalists, little has been done other than talk. Even though some hesitant steps have been taken, it was not until Al Gore's movie hit the screens that public attention was galvanized.

Just like the dandelions in spring, it is impossible to avoid the call to environmental action. Everyone is trying to do the right thing. Few manufacturers or suppliers don't have at least some 'green' product or message, whether or not there is any substance to the claims. Sadly, too many have little substance. In fact, there is so much talk that organizations with the sole purpose of evaluating competing green claims are now sprouting.

So it was a surprise to learn just how serious the Europeans are getting about the issue. The European Union is about to beef up laws covering environmental protection. A new directive would designate a number of activities that affect the environment as criminal offences in all member states.

The European law would mean that polluters, garbage cheats and corner-cutting industrialists could all find themselves facing criminal charges, rather than just civil penalties. The new offences would cover serious pollution incidents, the shipment, transport and disposal of waste, improper handling of nuclear materials, operating an industrial plant in a way likely to cause substantial environmental damage, making or selling ozone-depleting substances, killing or trading in protected plant and animal species and causing significant habitat deterioration within a protected site.

With today's political climate in Canada, it will be a while before there is comparable action taken here, however, there is a lot of desire to move in the right direction even though the debate rages about the best way to get there. Some want it to be done strictly by voluntary action, others by regulatory fiat, while others search for some combination of the two.

It is in this context that it is sad to see the direction the Home Builders' Association is taking on green labelling initiatives. Although CHBA published a very positive position paper on the environment only a year ago, now it is supportive of some voluntary green labelling initiatives, but is adamantly fighting others, even though no system is perfect, and each has its strengths and weaknesses.

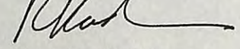
A major concern for CHBA is that some labelling initiatives might become regulation, although none of the labelling programs was designed as a regulatory tool, and their proponents are the first to state it. Underlying CHBA's position seems to be a 'don't regulate' stance.

Thinking that there is no room for regulations to move in more environmentally appropriate directions is simply wishful thinking. Action needs to be taken, and the public wants to see action.

Marketers use fancy bell curves to graph where the market lies. There are always the early adopters, the leaders that will take action to be at the leading edge of technology. These are fashion setters that often push the limits. In the middle lies the great mass. At the bottom end are the laggards, those that won't move unless they absolutely have to, and it is these 'bottom feeders' that inevitably have to be moved along by regulation. The issue is one of just where are those bottom feeders today, and how far does everyone have to go at what cost.

Given what we know about the sorry state of the environment today, largely the result of a century of human activity, we simply must take aggressive and definitive action. That action needs to be forceful and unfortunately it will require a strong measure of regulation to ensure the laggards are not allowed to linger. It is the business-as-usual approach that got us into the predicament we are facing, and we've got to break out of it.

We have the creative ability to move in the appropriate direction. We should take action, look for the most expedient way to move forward and not fight a rearguard action.



Richard Kadulski,
Editor

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Code Ventilation Requirements

Good ventilation is hidden and understood by few. It is silent and not felt. Its health benefits are measurable but of special concern to about 25% of the population.

The evidence gained through thousands of airtightness tests across the country has shown that new houses are increasingly being built more airtight. The trend to more airtight construction is not new – it has been with us for the past 50 years or so through the introduction of new products and construction techniques and increased expectations for more comfortable and energy efficient homes.

In heating climates, the pursuit of thermal comfort and energy efficiency has resulted in the use of more insulation and especially air sealing. In the minds of many we have gone too far in air sealing our houses, compromising indoor air quality. However, air sealing is also important to ensure a more durable building envelope – to prevent moisture problems as a result of interior moisture condensing on colder elements within the construction assembly.

When ventilation is inadequate or ineffective, moisture from people and household activities, along with odours and carbon dioxide will accumulate, raising the interior humidity level and lowering the indoor air quality. This can lead to mould, mildew and growth of dust mites that can trigger allergy, asthma, eczema and cause fatigue for some environmentally sensitive people.

Traditionally, a significant portion of the air change in houses was generated by the airflow up the flue and through cracks and holes in the building envelope. Houses were not airtight – in fact, they were often very drafty. But that uncontrolled air change kept the indoor environment somewhat in check. Studies done by CMHC a number of years ago showed that some of the very leaky old houses had worse indoor air quality than newer homes that had basic code compliant mechanical ventilation systems.

In any case, many people, including most in the building industry, believe that if the house is not airtight, but quite leaky, it will provide equal or better indoor air quality than that which could be provided by mechanical ventilation. One problem is that the air change does not remain constant throughout the winter, but varies with outdoor conditions. In addition, the ventilation need in a home varies with occupancy and this need drops quite drastically as the temperature falls below the freezing point.

'Natural' ventilation is ineffective in many ways, and in fact may be unattainable, and is highly undesirable from a comfort point of view. It becomes excessive in cold windy weather especially in three-storey dwelling units with a chimney for open combustion appliances. Conversely, in mild weather, smaller single-level dwelling units with radiant or baseboard heat will have little or no infiltration into a bedroom. Natural ventilation seldom reaches the room that needs.

If today's homes relied only on the air leakage through the building envelope for fresh outdoor air, then 70% of them would have less than 0.3 air changes per hour (ACH) over the heating season, and 90% would have at least one month when the air change rate would be less 0.3 ACH.

Houses normally do not need 0.3 ACH all the time. However, it has been recognized that about 0.3 ACH for the average modestly sized house is a suitable minimum level for health and comfort. If this rate cannot be achieved, most households will experience poor indoor air quality and high humidity levels at some times. Of course, this would result in maximum airflows in colder weather, and insignificant flows during mild weather conditions.

Modern heating systems have changed the airflow dynamics in a house. Electric heating and high efficiency combustion appliances eliminate the need for open flues, so there is no airflow up a flue.

The increased use of such heating systems

Why do we need ventilation in our homes and buildings?

The purpose of ventilation is to maintain healthy indoor conditions for occupants.

Every day, an adult inhales about 54 pounds (24 kg) of air, compared to about 5 pounds (2.2 kg or 2 litres) of water and 1 pound (½ kg) of food (dry weight). Although air is our body's most important environmental intake, we give less thought to air quality than we do to the water we drink and food we consume.

Ventilation for occupants must not be confused with ventilation requirements for the structure or combustion air requirements for combustion equipment, which is part of the heating system.

Table 1

Total Ventilation Capacity (CSA F326)		
Room	Capacity	
	l/s	*Cfm*
Master bedroom	10	*21.18*
Other Bedrooms	5	*10.59*
All other rooms	5	*10.59*
Unfinished basement (>2/3 of total area)	10	*21.18*
Hallways, vestibules, storage rooms, mechanical rooms, or other service areas not typically occupied are not counted as part of room count.		

combined with more emphasis on sealing the building envelope has led to a concern that the natural air change may sometimes be inadequate to provide a healthy environment. Condensation problems resulting from higher humidity levels with the dwelling are also a concern. That is why the Building Code has included requirements for mechanical ventilation for many years.

Heating Season Mechanical Ventilation Requirements

The National Building Code requires that every house must have a mechanical system that complies with CSA Standard F326 "Residential Mechanical Ventilation Requirements." This is a comprehensive performance standard that offers flexibility for those experienced in ventilation system design. However, because it is a performance standard, it requires professional design to prove compliance. A prescriptive alternative that meets the performance requirements has been written into the code. As a result, Section 9.32 (Ventilation) offers a choice of "prescriptive" and "good practice" options for compliance with ventilation requirements.

Although there is some debate about the contents in F326, and it could be tweaked, the standard is based on sound scientific criteria related to the amount of air an individual requires. That is why ventilation capacity is based on a room count rather than being scaled on the basis of the size of the house. Larger houses don't automatically have larger occupancies, rather they have larger rooms for the same number of occupants.

Table 2

Exhaust Capacity of Principal Ventilation Fan NBC 9.32.3.3.(2)				
Number of bedrooms	Exhaust capacity			
	Minimum		Maximum	
1	16 l/s	*34 cfm*	24 l/s	*51 cfm*
2	18 l/s	*38 cfm*	28 l/s	*59 cfm*
3	22 l/s	*46 cfm*	32 l/s	*67 cfm*
4	26 l/s	*55 cfm*	38 l/s	*80 cfm*
5	30 l/s	*63 cfm*	45 l/s	*95 cfm*
More than 5	Must comply with F326			

Ontario and BC have modified Section 9.32 significantly, changing minimum ventilation requirements, although both maintain the reference to CSA F326 as a code compliant standard. However, any builder building a certified R-2000 home or Built-Green Platinum home will automatically have to follow the F326 requirement, as that is part of those program requirements.

System Capacity

The ventilation system capacity is essentially related to the number of people in the house rather than to the volume of the house. Total system capacity is based on the number and type of rooms. For systems in full compliance with CSA F326 (typically HRV systems) the system is sized as noted in table 1. For example, a three-bedroom house, with family room, recreation room, two bathrooms and basement requires a total ventilation capacity of 130 cfm (65 l/s) and will normally be operated at half the capacity.

The minimum NBC system is sized based on the number of bedrooms in the house (see table 2). Ventilation can be supplied by a single fan or combination of fans, but clearly labeled controls must allow the airflow to be reduced to 50%. If the principal fan is controlled by a dehumidistat or other automatic control, a manual switch must be able to override the automatic control.

Ventilation in Homes with Forced Air Heating

For a ventilation system connected to a forced air heating system, the heating ducts are used to circulate the outdoor air. The furnace must be wired so that whenever the principal fan is running, the furnace fan runs and fresh outdoor air is brought into the heating system's return air plenum (upstream of the connection to the furnace). Minimum duct sizes will depend on whether the supply air enters passively or through an auxiliary supply fan.

Outdoor air can be tempered before it reaches living areas of the house by mixing it with the return air in the furnace's return air plenum. A 3m minimum distance between the furnace and the outdoor air supply duct connection is specified to enable a thorough mixing of air before the cold air reaches the furnace heat exchanger. This will avoid condensation that could occur resulting in reduced heat exchanger life.

Exhaust fans must be coupled to an air intake such as a duct from the exterior into the return air system of a forced air furnace to limit pressure unbalance in the house. The size of the exhaust is limited to prevent over-ventilating and to avoid excessive depressurization of the house.

A system run constantly at full capacity could make the house very dry and the heating bills very high, so the occupants might simply turn the ventilation off and forget it.

Ventilation in Homes without Air Heating Systems

If there is no forced air heating system or, if it is decided not to use the heating system to distribute the outdoor air, then a dedicated distribution system must be installed. Because the system only handles ventilation air, smaller ducts can be used and the supply fan can be smaller than a normal furnace circulation fan. The supply fan must operate at the same time and rate as the principal exhaust fan to avoid either pressurizing or depressurizing the house.

Distribution

Fresh outdoor air brought into the house must be distributed to the living areas, especially to the bedrooms. This requirement is in the code because of the evidence of poor air quality in the bedrooms of houses that do not have air circulation.

The fresh air must be provided to each bedroom and to each floor (including the basement). In houses where there is no storey without a bedroom (e.g., a basement-less bungalow), ventilation air must be supplied to the main living area.' This is simple in houses with forced air heating systems because the heating ducts do double duty as ventilating ducts. Houses without forced air heating, such as baseboard or radiant heat, need a system of small ducts to distribute the outdoor air to each bedroom and to each storey without a bedroom.

Outdoor air must be tempered before being circulated through the house. This can be accomplished by using a heat recovery ventilator, a heating element in the incoming air duct or by mixing it with indoor air. However, the latter approach is more complicated as it requires careful design and balance of the airflows between the outdoor air and indoor air ducts. It is too complex to deal prescriptively so where tempering by mixing with indoor air is chosen the system must be designed to meet CSA F326.

Fresh air supply grills must be put in the ceiling or high up in the wall, (within 300 mm of the ceiling).

Ducts must be sized correctly. Measurements of installed fans have found that kitchen and bathroom fans often deliver about half the flows, mainly because of incorrect installation. That is why tables lay out minimum duct sizes required for each fan. These are to be used where specific recommendations are not provided by the fan manufacturer.

Supplemental Exhaust

Kitchen and bathroom exhaust fans are required to remove contaminants near their point of origin.

Each kitchen must have an exhaust fan with a minimum capacity of 50 L/s (105 cfm) and each bathroom at least 25 l/s (53 cfm). The total of the supplemental fans must add up to at least the difference between the total ventilation capacity and the capacity of the principal exhaust fan.

Downdraft cook tops have fans that vent to the exterior. These have to overcome natural forces, so they are very powerful, and can depressurize houses to unsafe levels. Most will require dedicated make-up air.

Protection Against Depressurization

Exhaust fans can cause spillage of combustion products from combustion appliances when the house is depressurized. Appliances vulnerable to pressure-induced spillage are those that draw combustion air from the house and are vented through a natural draft chimney. Examples in-

Summary of 2005 NBC Ventilation Requirements

Principal exhaust and supply
- Capacity based on room count
- Must be able to ventilate continuously
- Supply and exhaust must be balanced
- Control by centrally located switch
- Ventilation air must be distributed to living areas
- Supply air must be tempered
- Fan capacity ratings at 62 or 100 Pa
- Fans must meet minimum sound rating

Supplementary exhaust
- 25 l/s for bathrooms not served by principal exhaust
- 50 l/s in kitchen if not served by principal exhaust
- Supplemental exhaust plus principal exhaust fan must equal or exceed total ventilation capacity
- Fans must meet sound ratings (NBC min 2.5 sones; BC 1.5 sone; should be less than 1 sone to be effective)
- Manual controls

Make-up air
- Must protect against soil gas entry and combustion gas spillage
- Must be installed for devices that exhaust more than 75 l/s
- Must operate automatically
- Incoming air must be tempered
- Must reduce pressure imbalance in house to not more than -5 Pa if there are spillage susceptible appliances, or -10 Pa otherwise.

Regretably, most houses fail to meet the Code ventilation requirements, and some quite hazardously. One of the biggest problems is that designers, builders and building inspectors don't understand the ventilation code so they ignore it.

clude gas furnaces and water heaters with a draft hood, oil furnaces with a barometric damper, open fireplaces and wood stoves. Appliances such as gas furnaces and water heaters with induced draft venting systems and the "sealed combustion" oil furnaces are resistant to spillage and do not require make-up air openings.

Most fireplaces are vulnerable to spillage, even those with so-called "airtight" glass doors and outside combustion air intakes, because "airtight" doors are not really airtight. Gas ranges must be vented to the outside.

A carbon monoxide detector must be installed on or near the ceiling of any room that has a wood burning fireplace or stove, unless the unit has tight-fitting doors that close off the firebox from the living area.

If the house includes combustion appliances vented through a chimney, then any exhaust device with a capacity greater than 75 L/s (158 cfm) must be provided with make-up air. The supply fan must be connected to the exhaust fan, so that it works simultaneously. The make-up air has to be tempered to at least 12°C before being introduced into the living areas. The size of the make-up air fan must be big enough so the net exhaust is reduced to 75 L/s. So for example, a 150 L/s downdraft cooktop fan would have to be wired to a 75 L/s supply fan.

Fan Sound Ratings

Ventilation system fans must be quiet so that building occupants do not turn them off. Fan noise level is expressed in "sones" tested by the Home Ventilating Institute (HVI). The higher the rating, the noisier the fan. The NBC states that the principal exhaust fan must have a maximum rating of not more than 2.5 sones. Experience in BC has been that is not sufficiently quiet, so BC has a limit of 1.5 sones, although even that is still too loud in many cases. In practice, a 1 sone fan noise limit is preferable.

Many kitchen exhaust fans have sone ratings greater than 3.5 so they cannot be used to meet the "for ventilation" capacity requirements. In this case, the kitchen exhaust may be met by the principal exhaust fan, if the principal exhaust fan is installed so that it withdraws all of its air from the kitchen.

Ducts

Except for exhaust ducts in kitchens, dedicated ventilation system ducts can be made of combustible materials (i.e. adequately sized plastic pipe can be used). Exhaust ducts must vent to the outdoors and not into an attic or roof space because venting into such spaces will lead to water condensation within the roof space that will eventually cause serious structural damage.

When exhaust ducts pass through unheated spaces, moisture can condense in them, so the ducts must be insulated with waterproof insulation able to withstand occasional wetting, and be airtight to prevent the transfer of moisture into concealed spaces through which they pass. Joints and seams must be sealed.

Supply ducts bringing outdoor air through a heated area (such as fresh air into the return air side of the furnace plenum) must also be insulated.

Kitchen exhaust ducts are subject to build up of grease deposits in them unless they are equipped with grease filters near the intake. The entire duct must be accessible for cleaning if it has no filter.

Heat Recovery Ventilators

The building code does not require the use of a heat recovery ventilator. However, if an HRV is installed, manufacturers' installation requirements, including balancing and sizing of air flows must be followed. When operating at the required rate, the two air streams must be balanced within 10% of each other.

The ventilators must be provided with a condensate drain, installed where it will not affect the operation of the system.

Outdoor Intake and Exhaust Openings

Intake and exhaust duct hoods are subject to rain and snow entry, and also to insects and rodents, so they must be shielded from the weather and be fitted with corrosion-resistant screens.

Air intakes must be clearly labeled, and must be at least 18" above finished grade, so in a location where the incoming air will not be contaminated by soil gases, automobile exhaust, oil or gas vents.

Fans designed to operate intermittently must be equipped with back draft dampers.

Letters to the Editor

Open Letter to Solplan Review and Mr. Ted Cullen, Vice President Marketing, P2000 Insulation Systems.

In the March 2008 issue of Solplan Review, Mr. Cullen stated:

"An example of a 'real world test' would be two identical buildings constructed to National Building Code Standards. One building would be insulated with R-20 fibreglass insulation, the other with one-inch P2000 Insulation." He continued by saying that the testing should be done by an accepted third party and that P2000 Insulation Systems will pick up the tab. His contention is that the P2000 house will use less energy than the equivalent house with R-20 fibreglass insulation, and that this will be proven over a year of monitoring. Conversely, most building scientists believe that P2000 has an insulation value of about R-4 for the 1 inch product, and that the reflective surface will have little additional effect in a typical wall assembly.

Mr. Cullen has made a remarkably generous offer. If carried out, the demonstration should resolve the discrepancies between claims made by P2000 and those of code bodies and building scientists. CMHC would be pleased to explore this possibility with Mr. Cullen. We need to establish together an appropriate place for the testing, specifications for the two houses, the degree of house finishing necessary, and how we would like the monitoring to be conducted. I am sure that the readers of this magazine would be interested in the results of any such experiment.

Don Fugler
CMHC Policy and Research
Ottawa, ON

If I'm concerned about global warming, what should I do with my banana peel?

"It appears that regulatory restrictions on the use of FWD [food waste disposers] have been the result of prejudiced opinion rather than objective assessment and that where impacts have been assessed objectively there has been shown to be no case for such restrictions."

That was the first "key finding" in a statement issued in 2004 – following a comprehensive review of the benefits and impacts of food waste disposers (also known as garburators) - by The Chartered Institution of Water and Environmental Management (CIWEM) in the UK.

In choosing science over myth, speculation, and unsupported bias, CIWEM's statement could have been addressing the wild rant posing as commentary published in the March 2008 issue of Solplan Review entitled "Garburators Create Problems, Not Solutions", by Charlotte Argue. It did not contain a single fact-based assertion, nor a single reference to any published research. It repeated discredited myths and misunderstandings about garburators..

In CIWEM's review of both extensive research studies and common practice, it cited the example of the Swedish town of Staffanstorp's thorough study of disposers, which concluded that they "provide a very good solution to the waste problem. No accumulation in drains or sewers was found, neither was there a change in water consumption. The change in wastewater treatment, biogas and biosolids offset the solid waste collection. The nutrients from the ground food waste improved biological phosphate removal."

And so the answer to the "banana peel" question is both surprisingly complex and simple: first, do whatever is necessary to keep it out of landfills; second, compost it (if you can do so reliably and effectively); but third, acknowledge that food scraps and human waste can be combined together for environmentally beneficial treatment at wastewater treatment plants.

And fourth: carefully examine the biases and prejudices of unsupported opinion in considering "new" approaches to challenging environmental problems.

Food waste disposers may have a useful place in the management of food waste and they might be a more convenient and environmentally superior alternative to separate storage and collection.

Kendall Christiansen
New York, NY

Kendall Christiansen is senior consultant on environmental affairs with InSinkErator, the leading manufacturer of residential and commercial food waste disposers; he chaired New York City's Recycling Advisory Board for nearly a decade. He is the principal of Gaia Strategies, a public affairs consultancy based in Brooklyn, New York.

Charlotte Argue replies:

Some of Mr. Christiansen's points are quite valid, but the majority of his arguments assume that there is biogas recovery in the wastewater treatment plants, that the sludge is

transformed into an appropriate biosolid used for fertilizer, and that the pre-existing wastewater infrastructure is well below peak load. The general consensus I have seen is that food waste disposers are often on par, not superior, to solid waste landfill systems in terms of overall environmental impacts.

My opinion is that manufacturers are using a form of green-washing to increase sales by arguing that food waste disposers are environmentally superior to other methods of waste management. In reality, it is highly location-specific.

Some municipalities have comprehensive sludge-biosolid plans, and if implemented properly – with aerobically digested waste and biogas capture – food waste disposers could be the best alternative, as Mr. Christiansen suggests. In reality the sludge often is ultimately taken to the landfill, even if it is treated.

I'd like to emphasize one of the biggest weaknesses in Kendall's argument: the assumption that sludge, or biosolids from wastewater treatments are safe to use from a health and environmental perspective. Although sludge does contain beneficial nutrients to soils such as phosphorous, nitrogen and trace elements, it also often contains inorganic chemicals such as heavy metals, as well as human pathogens and other unwanted products such as pharmaceuticals. Treatment can be very complex and expensive and not all municipalities have the facilities or the resources to do so.

It comes down to whether we should be mixing clean waste (household compost materials) with contaminated waste (municipal sewage sludge).

Readers who wish to do some more research or reading on the subject can check out:

Numerous contemporary studies, reports and analyses regarding the environmental efficacy of food waste disposers – among other options – can be found at *www.insinkerator.com/environmental.shtml*

Diggleman and Ham (Waste Management & Research, Vol. 21, No. 6, 501-514 (2003)

Sven Lundie and Gregory M. Peters, Life cycle assessment of food waste management options, Journal of Cleaner Production Volume 13, Issue 3, February 2005

Sludge into Biosolids: Processing, Disposal, Utilization, by Ludovico Spinosa, & P. Aarne

EQuilibrium Sustainable Housing Demonstration Initiative for BC, the North and Atlantic Regions

Canada Mortgage and Housing Corporation (CMHC) has issued a request for proposals for Equilibrium housing projects in British Columbia, the North and Atlantic regions.

EQuilibrium is a national housing demonstration initiative, led by CMHC, that brings the private and public sectors together to develop homes and eventually communities, that address occupant health and comfort, energy efficiency and renewable energy production, resource conservation, reduced environmental impact and affordability. The first competitive process initiated in May 2006 for the design and construction or renovation of EQuilibrium demonstration home resulted in the development of projects in the Prairie provinces, Ontario and Québec.

This request is for builder/developer-led teams who intend to build houses that respect the EQuilibrium goals of Occupant Health and Comfort, Energy Efficiency, Resource Conservation, Environmental Impact and Affordability. The projects will propose approaches to high quality sustainable housing and promote healthy sustainable communities in the targeted regions. In achieving these goals they will build capacity in the renewable energy sectors for the delivery of net zero energy housing in Canada and abroad.

To be eligible for consideration, projects:

- Must be new single-family, semi-detached, row, duplex or triplex dwellings or retrofit projects.
- Must be located in areas that are accessible for demonstration to the residential construction industry and public.
- Teams must be led by a builder/developer licensed and experienced in the region where the project will be located.

The deadline is July 14, 2008. One project proposal will be selected in each region and the successful teams will be invited to finalize designs and then construct or renovate, and open their EQuilibrium housing projects to the public. CMHC will provide technical, marketing and communications support, and will monitor and report on the performance of each project.

The Request for Proposal (RFP) documentation is posted on MERX. Details: *www.merx.com* [file number 0981-305-1].

For more information on the RFP and the CMHC EQuilibrium Sustainable Housing Demonstration Initiative, visit www.cmhc.ca and type search keyword "EQuilibrium".

You Asked Us About: Vapour Barriers

We are renovating an older house built in the late 1920s. Right now it has some cellulose insulation in the exterior walls, but the homeowner wants that replaced and all walls to be fully insulated. We are working mostly on the exterior, refinishing the exterior siding, so it should be relatively easy to access and insulate from the outside, as we don't want or need to redo all interior finishes.

I am concerned about the change in the performance of the wall, because the insulated wall will not have a vapour barrier. I don't want moisture accumulation to be an issue as we increase insulation. What can we do?

You say that the house is an older house that doesn't have a vapour barrier. However, you are mistaken. That older house has a very good vapour barrier in place; it may not be the polyethylene you are thinking of. You may not think of it this way, but the many coats of paint or wallpaper that have been applied over the years do provide the vapour diffusion resistance that is expected of a vapour barrier – they reduce the vapour diffusion through the assembly.

It is important not to think that you must have a continuous sheet of polyethylene. What is far more important is to have a continuity in the ***air barrier****. This need not be a single material, but a combination, as long as there is continuity by way of caulking and sealing between the components. Any material that resists air movement can do the job.*

The main source of moisture problems in walls actually is inadequately executed construction details in the exterior envelope – poor or non-existent flashing details and excessive reliance on face sealing the exterior finishes.

Your question highlights a common misunderstanding that many have about the difference between air barriers and vapour barriers. The building code recognized the confusion and has separated the requirements into two separate articles – 9.25.3 identifies the need for and defines air barriers, and 9.25.4 defines vapour barrier requirements. Because of the continuing interest in the topic, we have updated and are reproducing a piece on the difference between vapour barriers and air barriers that we first published in one of the first issues of Solplan Review, back in 1985.

Air Barriers and Vapour Barriers: There is a difference

Since the 1970s we have been actively pursuing more airtight home construction. This came about because it was realized that air leakage was a major factor in house heat loss, but more importantly, moisture problems.

Infiltration and *exfiltration* are factors in air leakage. Infiltration is the flow of air into the house through openings in the exterior building envelope. Exfiltration is the flow of air out of the house. Under the right conditions, each of these air streams causes considerable damage to the building.

The concern about exfiltration is that moist, warm indoor air can lead to structural deterioration. Moisture condensing on a cold surface within a wall or roof can provide ideal conditions for fungus and rot to attack any organic material.

Infiltration not only means cold drafts into the house (meaning a loss of heat from the house) but it is also a means by which outdoor contaminants can enter the house.

To move air between the inside and outside, whatever the direction, there must be a pressure difference between inside and outside. A pressure differential is created by wind acting on the building envelope or by a temperature difference. On the windward side, positive pressure causes infiltration into the house. On the leeward side, negative pressure encourages exfiltration. Similarly, a temperature difference between inside and outside will generate a stack effect within the house, leading to warm indoor air escaping through the upper parts of the house.

Air movement in and out of a building will take place through holes or gaps in the construction, such as around window and doorframes, electrical outlets, plumbing or service penetrations and any connections between building materials, such as between wall/floor plates.

To control the movement of air and moisture through the building envelope, there is a need for both an air barrier and a vapour barrier. When attention started to be given to air sealing buildings, sheets of polyethylene were used, and the term 'air-vapour barrier' was coined and became the common term to describe an element that stops both air movement and has the characteristics of a vapour barrier.

Vapour Barriers

The principal function of a vapour barrier is to stop or retard the passage of water vapour through the pores of a material. The rate at which water vapour migrates (or diffuses) depends on the difference between the water vapour pressure in the air inside the building and that in the outside air, and the resistance that materials present to the migration of moisture by diffusion. Contrary to popular belief, a vapour barrier need not be perfectly continuous. Unsealed laps, in holes, small cuts, etc. do not increase the overall moisture diffusion rate into a wall or roof cavity.

The National Building Code has set the criteria for a vapour barrier as any material with a permeance not greater than 60 ng/Pa-s-m^2. This is also referred to as 'one perm'.

Materials that are effective vapour barriers have a low permeance to water vapour. Typical vapour barriers are polyethylene, foils, vapour retardant paints, foil-faced drywall and insulation boards, closed cell extruded and spray-applied foam insulation products, and plywood.

It is important to note that there is a difference between water vapour and (liquid) visible moisture. Many materials that appear to repel moisture are permeable to water vapour.

Vapour barriers must always be located on the warm side of the wall above the dew point, otherwise condensation will occur on the cold surface. This means that a vapour barrier can be placed part way into the wall. The National Building Code Table 9.25.1.2.A points out allowable inboard to outboard thermal resistance ratios, based on climate severity.

One may at first question placing a vapour barrier part way into an assembly, but that is what happens when an exterior wall is sheathed with rigid foam insulation. In the 1980s, some enterprising builders were placing polyethylene on the interior of the stud framing, then strapping the interior for extra insulation value. Others looked at double wall construction. Although these may seen like extreme attempts to increase insulation, with the current drive for greater energy efficiency and even net-zero energy or EQuilibrium homes, we will see more use of what was previously considered extreme insulation strategies.

***The Difference Between a Vapour Barrier and an Air Barrier**, by R.L. Quirouette, 1985, Building Practice Note 54, National Research Council Canada.*

Air Barriers

The principal function of an air barrier is to stop outside air from entering the building through the building envelope, and inside air from exfiltrating to the outside. An air barrier stops the movement of air under pressure through the building enclosure. Moisture laden air passing through an insulated cavity with a vapour barrier may deposit many times more moisture than would diffuse through the vapour barrier in the same period of time.

Air leakage through openings in the building envelope is caused by air pressure differences, and the stack effect (which is dependent on a temperature difference between inside and outside). The higher the house, the more pronounced the stack effect. A second mechanism is the pressure difference across the building envelope – this could be the result of wind forces acting on the building. The third is ventilation equipment that creates a pressure differential across the building envelope.

An air barrier does not have to meet the vapour diffusion requirements of vapour barriers. Air barriers can have a high permeance to water vapour. Any structurally supported building component can be used as an air barrier, and the air barrier may be located at any point in the envelope – on the interior, exterior or part way through the assembly. But to be effective, the air barrier must be applied properly and all joints sealed. Examples include drywall, plywood, polyethylene sheet, spun bonded polyolefin housewraps, foam insulation and structural components. Building paper is not an air barrier.

Some materials can act as both air and vapour barriers. Never create a vapour barrier on the exterior of the building. If a vapour barrier is applied properly on the warm side of the wall, provision has to be made to allow any moisture in the wall framing (especially in new construction) to escape outside.

Although poly has become standard, other materials may actually be preferable, because that nominal amount of additional permeance – the difference between 3 ng/Pa-s-m^2 (the permeability of poly) and the code defined limit for the vapour barrier of 60 ng/Pa-s-m^2 – allows for a small amount of drying to take place, and reduces the potential build-up of moisture behind the poly.

Remember, air barriers are not necessarily vapour barriers; only moisture needs be stopped on the warm side of the wall. An air barrier is essential for energy conservation and building durability.

How Green is your Home? – A Cross-Canada comparison of programs

'Green' building practices are the new buzzword. Today there a strong demand for buildings that are healthier for their occupants and healthier for the environment.

Green buildings are energy efficient and offer an improved, more comfortable environment for the occupants as well as long-term savings. They have better indoor air quality. Better built, they are more durable, which means a longer life for the building. With careful selection of materials they also preserve more natural resources for future generations. In sum, environmentally preferable design and construction reduces the impact a building has on both people and the environment.

However, sustainable building practices go beyond water conservation, resource efficient building materials and water conservation. The energy that a house will use over its life will far outweigh the embodied energy content in construction materials and construction processes. That is why energy efficiency is perhaps the most important element of a 'green' building. That is also why houses built to the R-2000 standard are still among the most energy efficient and environmentally appropriate homes today.

R-2000

The R-2000 standard sets an energy performance target for homes that today is about 30% more efficient than conventional current practice. The R-2000 standard was launched in 1982 and has been updated over the years to ensure it remains at the forefront of construction technology. Over the years, requirements for indoor air quality and resource conservation have been added, along with stricter energy targets. It is presently undergoing another review, and the energy performance target will be made more stringent.

Although the number of certified R-2000 houses may be modest, the standard has influenced the way every home is built today, spawning a new generation of better builders, better materials and products and better homes. It has also been the cornerstone of Canadian housing export programs in Japan, the UK, Ireland, China, and other countries.

Energuide Rating Service

Recognizing that R-2000 is a strict standard with absolute pass/fail criteria that make it difficult for production builders to meet in all cases, the EnerGuide Rating Service (originally called EnerGuide for New Houses or EGNH) was developed by Natural Resources Canada to help improve the energy efficiency of new houses.

An EnerGuide rating is a standardized measure of a home's energy performance. The home's energy efficiency level is rated on a scale of 0 to 100. A rating of 0 represents a home with major air leakage, no insulation and extremely high energy consumption – typical of older homes that have not been updated over the years. A rating of 100 represents a 'net zero energy' house – one that is airtight, well insulated, sufficiently ventilated and requires no purchased energy. Current conventional construction of new homes is in the range of 70-74, depending on the region and house characteristics, while an R-2000 house rates a minimum of 80.

The EnerGuide rating has been seen as a useful tool for new home initiatives by utilities, homebuilder programs and government agencies across the country. All incorporate an EnerGuide rating requirement as part of their criteria.

Built-Green™

Built Green™ is a voluntary homebuilders' certification program in Alberta and BC for improving the energy and environmental performance of new houses. It has an extensive environmental checklist as well as an energy efficiency requirement. The program has four levels of achievement – Bronze, Silver, Gold or Platinum. Each level requires a minimum number of points from the checklist, plus a minimum EnerGuide rating. A Bronze home must achieve a minimum EnerGuide rating of 72, Silver 75, Gold 77, and Platinum 82.

BC Hydro Power Smart New Home Program

As part of their energy conservation and demand management initiatives, the BC Hydro Power Smart New Home Program encourages energy-efficient homes. Under their Power Smart

R-2000

For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000
www.R-2000.ca

branding, a home receives a Power Smart Silver label when an EnerGuide 77 rating or higher is achieved, and a Power Smart Gold Label for a home that achieves a rating of EnerGuide 80.

Energy Star® New Homes

This is a program developed in Ontario, and now also used in Saskatchewan. These programs are managed for Natural Resources Canada by regional service organizations. The Energy Star program is largely a prescriptive program with the builder having a range of options to select. The average Energy Star new home achieves an EnerGuide rating of 77 or higher.

Manitoba Hydro

Manitoba Hydro's Power Smart New Home Program is a prescriptive standard, so although it is not directly linked to a specific EnerGuide level, it provides a similar result.

Requirements for Manitoba Hydro's Power Smart Silver include:

R-50 attic insulation with raised heel truss; R-20 foundation insulation; Energy Star programmable thermostat; high efficiency natural gas furnace, electric furnace or geothermal heat pump; air tightness of 2 ACH/hr. Additional requirements include at an option of at least two of: ECM (electrically commutated motor); HRV (heat recovery ventilation); a permanently wired car plug timer; or electric hot water tank with a minimum of 2" insulation; gas fireplace with electronic ignition (preferred option) or HRV (heat recovery ventilation); energy efficient lighting in every room.

Requirements for Manitoba Hydro's Power Smart Gold include:

R-50 attic insulation with raised heel roof truss; R-24 foundation walls; R-26 above grade exterior wall (for electrically heated homes); Energy Star programmable thermostat; high efficiency natural gas furnace, electric furnace or geothermal heat pump; electric hot water tank with 2" insulation; air tightness of 1.5 ACH/hr; HRV; permanently wired car plug timer. Additional requirements include at least two of: energy efficient lighting or ECM (electrically commutated motor); higher efficiency of HRV; gas fireplace with electronic ignition.

Novoclimat

Novoclimat is a Quebec initiative that allows builders to increase the energy efficiency of their homes by building to the Novoclimat technical standards. An energy evaluation is done on the completed home and a Novoclimat certificate is provided to the homeowner. Novoclimat homes meet an EnerGuide rating of between 78 and 80.

Yukon GreenHome

To encourage energy efficient housing, Yukon Housing Corporation has developed the GreenHome Certification Program which offers owners a preferred interest rate on mortgages for a certified GreenHome. Program requirements include an EnerGuide rating of at least 80, the house must pass an air leakage test, and the ventilation system must be approved by a GreenHome ventilation advisor or a professional engineer. In addition, the house builder is to be a Yukon business or Yukon resident and a minimum of 75% of all building materials must to be purchased through a local supplier.

Green Building Impacts

Is there a measurable impact of green home programs? The Built-Green™ program has enrolled more than 7,700 housing units since its launch in 2004. The average EnerGuide rating in 2004 was 74 (this was in Alberta only - BC joined the program in 2006). This has moved up, so that the average rating for new houses is now approaching 80. The highest achieved to date is 88.

The average reduction in greenhouse gases (CO_2) per house, compared to code construction, is about 3 tonnes per year, so over a 25-year period, 1,000 Built-Green homes would result in a reduction of 75,000 tonnes (or more) of CO_2.

The reduction in water consumption, through the use of low flow toilets, shower heads and major appliances, averages 176,565 litres/year/house. This means that cumulatively, there has been a reduction in water use of more than 1 billion litres. This means a reduction of loads on the civic infrastructure, and is especially important in regions with limited water availability, such as in Southern Alberta.

Technical Research Committee News

Canadian Home Builders' Association

Codes and Standards

Provincial adoption of the 2005 National Building Code in most jurisdictions has now been completed.

Confusion has emerged as to whether induced draft (power-vented) gas appliances fit within the definition of mechanically vented, and thus avoid triggering the requirement for make-up air. Alberta has ruled that power-vented appliances require make-up air.

Another issue that has emerged is the confusion about make-up requirements. In particular, the question is whether power-vented appliances are exempt from make-up air requirements. Consideration is being made to change the terminology to 'mechanically vented'.

The Standing Committee on Houses and Small Buildings (Part 9) has been working on proposed changes for the 2010 code edition. Significant change proposals may be coming for lateral loads, spatial separation, new window and door standards, stairs and handrails, party walls, secondary suites, radon mitigation and a new installation standard for hydronic heating. Proposed code changes will be circulated for public comment later in the year. CHBA has been a party to the discussions.

CHBA has developed recommendations for enhancing the R-2000 Standard, and is circulating a draft among R-2000 builders and service providers for comments prior to formally presenting the proposals to NRCan, which is the authority behind the Standard. CHBA would like to re-establish the R-2000 Standard as the 'beacon' which other voluntary initiatives will aspire to emulate for high quality environmental performance.

Preserved Wood

The National Building Code mandates the use of treated wood in some locations. The recent switch from CCA to ACQ treatment of wood has created problems. The consequences have been severe because the ACQ formulation is much more corrosive than CCA and requires use of special connectors – mostly stainless steel. The concern is compounded by the quirk that preservative standards allow a wide range of carrier products, which means that the way lumber is treated may vary from supplier to supplier for ostensibly the same product. A study supported by the Homeowner Protection Office in BC is looking at the corrosion implications of ACQ treated lumber.

The wood preservation industry is also considering alternate preservation materials, including formulations that are copper-free.

Greening the BC Building Code

In support of the BC Government's commitment to reduce greenhouse gas emissions, changes to the BC Building Code have been made and come into effect on September 5, 2008. The changes are meant to increase energy and water efficiency of new construction in BC and will apply to all new construction and renovations in BC. They address three areas:

1. Energy Efficiency Requirements for Single Family Houses and Smaller Multi-Family Residential, Commercial and Industrial Buildings. Current prescriptive requirements are increased modestly, although an alternate compliance path is to show the house achieves an EnerGuide Rating of 77, verified by a licensed EnerGuide energy advisor or an equivalent performance by computer modelling.
2. Water Efficiency Requirements
3. Energy Efficiency Requirements for High-Rise Multi-Family Residential Buildings and Larger Industrial, Commercial and Institutional Buildings

These changes are seen as the first step in meeting the province's Throne Speech commitments to reduce greenhouse gas emissions related to buildings and construction. These code changes will be followed by additional changes in the coming years to further reduce the environmental footprint of buildings throughout their lifespan. Areas under exploration include greywater recycling, the use of lighting sensors and the reuse of existing buildings.

The stated goal is to increase the requirements in 2010 to an equivalent of EnerGuide 80.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
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Typical winter scene in Canada's north, with fine snow blown onto walls and windows.

Research on Building Envelopes for Extreme Climates

By M.Z. Rousseau

Building envelope technologies commonly used in Canada's "south" are not necessarily effective in the northern parts of Canada, i.e. regions near and above the 60th parallel, where the conditions of exposure and construction can be very different. Considering the high cost of construction and operation of buildings in remote locations, significant benefits can be reaped by improving the energy performance and service life of the housing stock. With that in mind, four years ago the Institute for Research in Construction (NRC-IRC), along with Canada Mortgage and Housing Corporation (CMHC), Natural Resources Canada (NRCan), and the Program of Energy Research and Development, undertook research to assess innovative technologies for wall assemblies from the perspective of energy and hygrothermal performance.

As the price of energy rises and the trend towards sustainable development and near-zero energy housing continues, it may well be that highly insulated envelopes could also become more popular in less cold parts of Canada. Upcoming NRC-IRC research will consist of laboratory evaluations in a climatic chamber and a modelling study using the hygIRC 2D numerical hygrothermal model developed by NRC-IRC.

Activities completed to date include a literature review on innovative technologies currently used in Canada or elsewhere, measurements of indoor air temperature and humidity levels in houses in the north, analysis of climatological data pertaining to the north, and consultation with communities in the three Canadian territories. Five innovative wall construction methods for extreme cold climates have been selected for assessment and will be benchmarked against a R-20 2x6 stud frame wall assembly (see table for description).

Highlights of measurements in homes

Over a one-month period, indoor air temperature and relative humidity (RH) levels were continuously measured in eight houses in each of three locations: the northern coast of BC, the Yukon and the Northwest Territories[1].

Some of the findings did not support the popular belief that higher levels of occupancy and excessive moisture-generating activities are the main contributors to moisture problems. The homes with reported moisture problems did not experience systematically higher relative humidity indoors than those without reported moisture problems. The homes with the most occupants did not necessarily experience more moisture problems or higher RH than those with fewer occupants.

In Prince Rupert (a cool and humid climate), the average daily indoor RH in May 2005 in the eight homes surveyed ranged from 36 to 65%. In Inuvik (very cold and dry), the average daily indoor RH in the eight homes surveyed in November 2006 ranged from 9 to 29%.

Other findings

☞ "Wet" rooms (bathrooms and kitchens) experienced peaks of RH much higher than the average RH. Bathroom peaks reached 100% RH daily in all houses surveyed. Monitoring in other rooms indicated more stable and lower RH conditions.

1 These surveys were conducted with the assistance of the Inuvik Housing Corporation, the Prince Rupert Housing Corporation and the Yukon Housing Corporation, as well as two regional building technology firms, Sheltair in BC, and Arctic Energy Alliance in NT.

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Description of wall assemblies selected for assessment

Test Frame [1]	Test Specimen	Test Wall Specimen
No. 1	W1	Typical R-20 2x6 construction Painted wood lap siding, housewrap, OSB, R-20 glass fibre batts, poly, painted gypsum board
	W2	Prefinished structural smart panel siding, housewrap, 2x6, 5.5 in. mineral fibre, poly, 2x3 strapping and 2.5 in. mineral fibre semi-rigid insulation, painted gypsum board
No. 2	W3	Hardboard lap siding, 1x3 strapping, housewrap, OSB, 2x8, 7.5 in. batt, poly, 2x4 strapping, 3.5 in. mineral fibre insulation, painted gypsum board
	W4	Hardboard lap siding, housewrap, load-bearing 6.5 in. SIP (with EPS), poly, 2x2 strapping with 1.5 in. mineral fibre semi-rigid insulation, painted gypsum board
No. 3	W5	Hardboard lap siding, housewrap, OSB, 7.5 in. I-joist and cavity filled with mineral fibre insulation, poly, 2x2 horizontal strapping filled with 1.5 in. mineral fibre insulation, painted gypsum board
	W6	Prefinished structural smart panel siding, housewrap, 2x6 with 5.5 in. mineral fibre insulation, 2 in. gap filled with mineral fibre insulation, poly, 2x4 studs with 3.5 in. mineral fibre insulation, painted gypsum board

1.Two test wall specimens will be evaluated side-by-side in the climatic chamber. An insulated and airtight separation between specimens will minimize lateral flow of heat and air.

☞In the Carmacks, Yukon, survey house, extreme indoor temperature fluctuations were a major contributor to moisture problems. Seven of the eight homes surveyed in January- February 2006 were heated with a central wood stove without a heat-distribution system, and the indoor temperature fluctuated between 8 and 34°C.

☞A large range of airtightness levels (5 to 19 ACH @ 50 Pa) was noted among the 24 homes [2]. None of the houses could be considered very airtight (e.g., 1.5 ACH@ 50 Pa), even though some were fairly new (less than five years old).

The monitoring of these 24 houses, which varied widely in construction and occupant lifestyle, has proven instrumental to NRC-IRC researchers in their quest to identify realistic extreme indoor conditions of RH and temperature. This information will provide the basis for the laboratory evaluations of the moisture control performance of wall assemblies that appear promising for these climates. The evaluations will start in the summer of 2008.

2 In NRCan's EnerGuide for Houses energy audit, a fan depressurization test to quantify the air leakage of the home was carried out without closing off intended openings, such as exhaust fan outlets).

The assemblies will be subjected to indoor temperature and relative humidity and pressure fluctuations, while at the same time extreme outdoor climatic conditions will prevail.

This fall and winter, NRC-IRC will present its Building Science Insight 2008-09 (BSI) seminar series entitled *Single and Multi-Family Houses: Improving Performance Through a Systems Approach* in 15 locations across Canada. In Whitehorse, Yellowknife and Iqaluit, the program will include two presentations specific to the outcomes of this northern research project. For more information on BSI 08/09, visit:

http://bsi.gc.ca

For more information on the outcomes and progress of the project, visit the website *http://irc.nrc-cnrc.gc.ca/bes/hmpe/north60_e.html.*

Energy Answers

Rob Dumont

Have there been any multi-family buildings in Canada built to very high levels of energy efficiency?

I am aware of a few.

About 1989, Closeleigh Manor was developed in Whitehorse, Yukon, as the first R-2000 multi. The Yukon Housing Corporation was the owner. The building incorporated relatively high insulation levels, a tighter building envelope, enhanced ventilation through direct supply to each room in each suite, heat recovery on the central ventilation system, and modular boilers. It also featured an innovative building layout (for Canada at that time) with ground floor commercial space and apartments above.

NRCan did a thorough job of monitoring the building, including whole building air tightness tests, measurements of the neutral pressure plane, and hour by hour computer simulations. I was involved with the air tightness testing. As I recall, we were able to air test the 33-suite building with one Minneapolis Blower Door. One wag boasted that "the blower door is sized for American houses or Canadian apartment buildings." One of the findings from the monitoring was that the original modular oil-fired boilers were over-sized for the load. As a consequence, half of the boilers were removed.

In 2000, an innovative multi-family building was built in Dundas, Ontario as part of CMHC's Ideas Challenge Program. Urban Horse Developments was the company who built the 48-unit, 6-storey project. The building featured relatively good insulation levels for southern Ontario, a well-sealed building envelope, individual heat recovery ventilators for the suites and for the corridors, elimination of thermal bridges at the balconies, energy-conserving appliances, and water-efficient toilets, shower heads, aerating faucets, dishwashers and clothes washers. Space heating, water heating, and electricity consumption in each suite were charged back to the individual suite owners.

The measured total energy consumption of the Dundas building was 137 kWh per square metre of floor area per year, which is more than 35% better than a building built to the Model National Energy Code of Canada. For the Dundas condo, the space heating consumption at 23% of total energy consumption was less than the water heating consumption (25%). Water consumption was reduced 75% compared with conventional apartment buildings, in large part because of the water conserving appliances and fixtures used.

The above two examples are not exhaustive, and no doubt there are other examples that I have overlooked.

Are apartments much different than detached houses in how they use energy?

I would say that there are three major differences. First, most tenants in Canada do not directly pay the space heating, water heating and water bills for their suites. As a consequence, windows are left open, temperatures are kept higher, taps are left to drip, toilets leak—the list goes on. In general, there is not the attention to the details of good management that you find in a detached house where the owner directly pays the energy and water bills.

A second difference is that apartment buildings are usually taller than detached houses, and as a consequence air leakage due to stack effect and wind is a bigger factor. The stack effect is roughly proportional to the height of the building in a given location. A four-storey building will experience twice the stack effect of a two-storey building. A taller building is also more vulnerable to wind forces.

A third difference between houses and apartments is that common areas such as corridors and entranceways are commonly lit 24 hours per day. I have yet to see an apartment in Canada that uses occupancy sensors to control hallway lighting

A truly energy efficient apartment building would have to address all three of the above factors.

Are there any general principles that you would recommend when developing an energy efficient multifamily building?

Here are a few ideas:

Overall Design

1. Use an integrated design approach. A great building envelope with good insulation levels, good windows and air tightness results in a much lower space heating system. Frank Lloyd Wright, probably the most famous architect of the modern era, once said that you should never put anything in a building that serves only one function. Integrated design can help the parts multi-task.

2. As much as possible, charge the individual suite occupants directly for their space heating, water heating and electricity use. In Denmark, it is the law that all space heating use in individual suites in multi-family buildings must be metered. Special heat meters (Kamstrup, Siemens, etc.) with liquid flow meters and platinum resistance thermometers are used to meter the amount of space heat. Research has determined that savings of approximately 15% in space heating can be achieved by this one measure alone. With each tenant responsible for their space heating bill, thermostats are more carefully controlled, and windows are not left open. What gets metered gets controlled.

3. Orient the building along an east-west axis so that passive solar heating is available in the heating season. This approach automatically minimizes east and west facing glazing, which are major sources of overheating in the cooling season.

4. Minimize space heating loads through careful design of the building envelope. Here are some recommendations I recently made for a new LEED Platinum multi-family building in Saskatoon:
   Ensure excellent air tightness (R-2000+)
   1.0 ac/h @50 pascals [0.5 litres/second per square metre at 75 pascals]
   R30+ Walls
   R60+ attic
   R-5 (Triple, low-e, tuned to orientation, argon, low conductivity spacer) windows.
   With these insulation levels, a typical suite should have a peak space heating load less than one kilowatt (3,413 Btu/h). With peak loads this low, a very simple heating system is all that is needed.
   A typical multi-family suite only has one exposed surface, as compared with a detached house, which has six exposed surfaces: roof, four walls, and foundation. A large, central boiler with perimeter baseboard heating under each window in the suite is not at all necessary in a well-designed multi-unit building.

5. Use renewable energy systems to provide the bulk of energy (plan for Net Zero eventually as component costs fall by allocating space for PV systems.) Use active solar collectors to provide space heating and domestic hot water.

6. For auxiliary space heat, use the domestic hot water loop to provide some space heating along with electric top up.

Space Cooling

7. Minimize cooling loads by reducing electricity use through the use of Energy Star appliances and compact fluorescent lighting. Use an instantaneous electricity readout device (The Energy Detective, Powercost Monitor, etc.) to allow occupants to optimize their energy use.

8. Incorporate low cost thermal mass such as using scrap gypsum board placed in the interior wall cavities. Provide cooling with night ventilation and through-the-wall high SEER AC units if needed.

Domestic Hot Water

9. Reduce domestic hot water loads with Energy Star appliances (clothes washers, dishwashers), low flow showerheads and aerating taps. Use a drain water heat exchanger on the showers.

10. Use flat plate solar thermal collectors to produce hot water. (Approximately 6 square metres per apartment). Use high efficiency natural gas for auxiliary DHW.

Ventilation

11. Carefully seal the building exterior envelope, and interior partitions and floors to compartmentalize suites and reduce stack effect.

12. Use low emitting surfaces (ceilings, walls, floors, cabinets) to minimize volatile organic compounds and the need for high ventilation rates.

13. Use a high effectiveness heat recovery ventilator (air to air heat exchanger) in each suite. Seek out units with low electrical energy usage.

14. Exhaust air from the bathrooms (and kitchen) and supply air to the bedrooms and living areas with ducts to provide excellent air circulation.

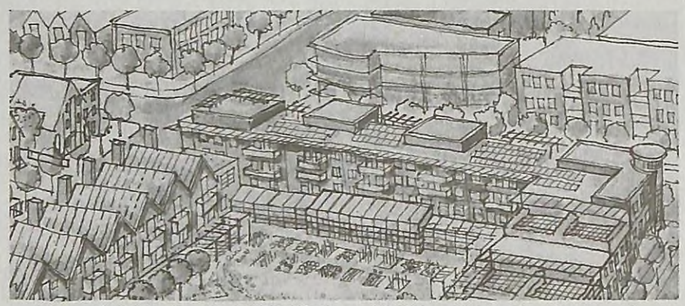

Figure 1. Multi-family LEED Platinum Building Under Development in Saskatoon (Rivergreen Summary Report Draft, April 2008)

15. Ventilate hallways and common areas with individual HRVs. To prevent odour transfer between suites, slightly pressurize the hallways with more supply flow than exhaust. With this approach, there is no need for a conventional large central ventilation system.

Domestic Cold Water

16. Use low flow toilets (4 litres/flush or less), Energy Star front-loading clothes washers, Energy Star dishwashers, and faucet aerators.
17. Use rainwater for non-potable purposes.
18. Minimize exterior water use through careful design of the landscaping using native plant species.

Has any multi-family building actually implemented such an ambitious strategy?

A project under design in Saskatoon called Rivergreen *(www.rivergreen.ca)* will likely incorporate most of these design approaches. The rendering shows a part of the development. The multi-family apartment part of the complex is oriented along an east-west axis. Visible on the roof are the active solar thermal panels. The building design will be finished later this year, and construction is expected to be completed in 2010. A design charrette was held in April 2008.

High Efficiency Gas Furnace Class Action Settlement

A class action lawsuit that applies to Carrier, Bryant, Payne, and Day & Night furnaces made and sold since January 1, 1989 has been reached. The lawsuit was about whether Carrier Corporation negligently designed, manufactured and failed to disclose alleged defects in the secondary heat exchangers of its high efficiency gas furnaces. The settlement provides benefits to those who own or owned a high-efficiency gas furnace.

This applies to anyone who currently owns a Carrier 90+% high-efficiency condensing gas furnace made and sold since January 1, 1989, and former owners of these furnaces who had a secondary heat exchanger failure. These furnaces were sold under the brand names "Carrier," "Bryant," "Payne," and "Day & Night." A list of the included models is available by calling 1-877-632-0916 or going to *www.furnaceclaims.ca.*

To request a payment for a past secondary heat exchanger failure, owners must complete and submit a claim form, available at *www.furnaceclaims.ca.* The claim form can be submitted online or by mail postmarked no later than September 8, 2008.

Carrier will pay eligible owners who had a secondary heat exchanger failure up to $270 and offer an enhanced 20-year warranty on secondary heat exchangers in their high-efficiency gas furnaces. Carrier will also provide a technical bulletin to furnace dealers to help identify furnaces eligible for coverage under the enhanced warranty. The settlement doesn't mean that any law was broken, and Carrier denies it did anything wrong.

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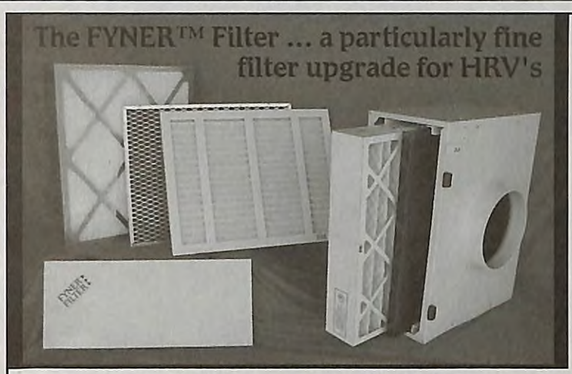

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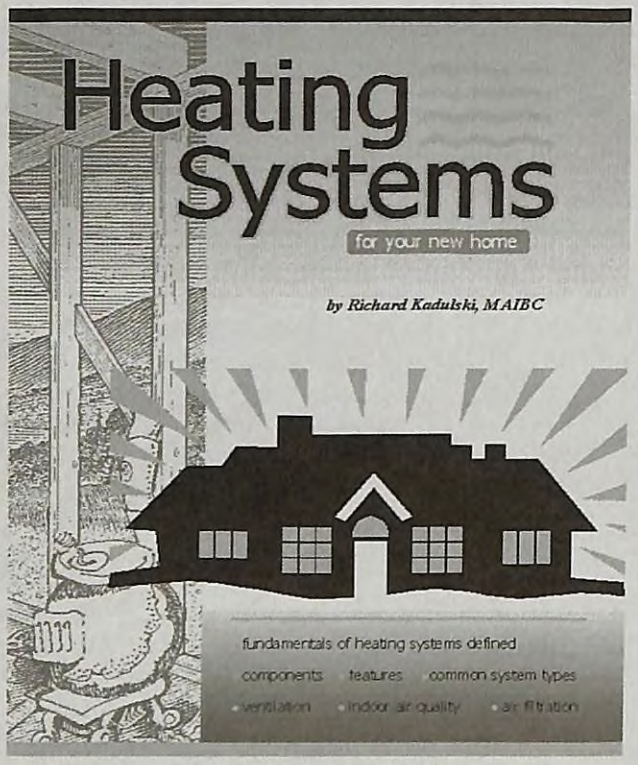

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